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(56) Documents cited

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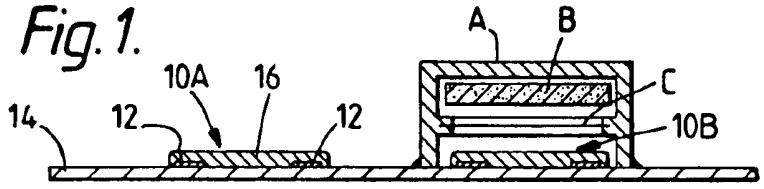
(58) Field of search
G1N
Selected US specifications from IPC sub-class G01N

(54) A humidity measurement or control instrument

(57) An instrument for use in humidity measurement and control, comprises two identical electrically resistive humidity sensors (10A, 10B), the sensors (10A, 10B) being disposed in physical proximity to one another, but with one of the sensors (10B) being kept in a sealed housing A at a predetermined set humidity and the other (10A) being exposed to the environment of which the humidity is to be measured. The humidity in housing A is kept at a predetermined set humidity by mounting within housing A a piece B of absorbent material impregnated with a saturated solution of salt or salts, body B being separated from the sensor 10B by a vapour phase permeable membrane C. A signal is derived from the sensors 10A, 10B, corresponding to the difference between the measured humidity and the set humidity, whereby the measured humidity may be determined as the algebraic sum of the predetermined set humidity and the difference.

Fig. 1.



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The drawing originally filed was informal and the print here reproduced is taken from a later filed formal copy.

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Fig. 1.

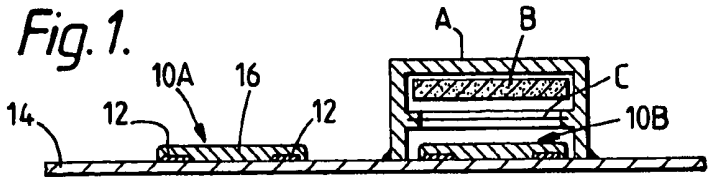


Fig. 2.

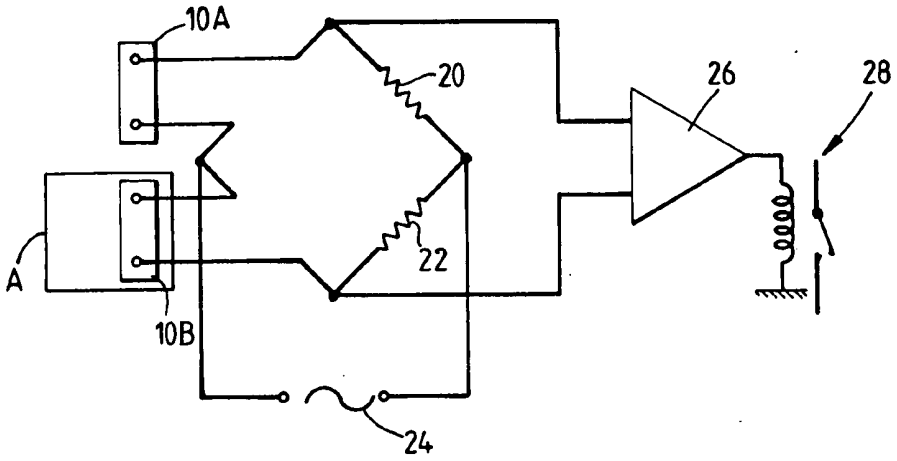
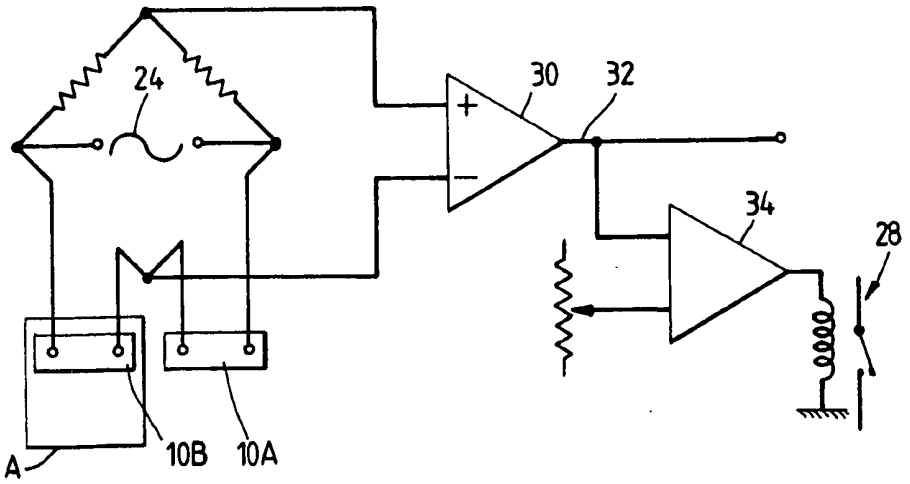


Fig. 3.



SPECIFICATION

A humidity measurement or control instrument

THIS INVENTION relates to an instrument for use in humidity measurement and control.

Known instruments for such use include devices utilising hairs or paper or plastic strips pulling against springs and, for example, arranged so that an electrical switch is closed at around a humidity "set point". Such devices (sometimes referred to as humidistats, suffer from several drawbacks such as hysteresis, drift with time or temperature, susceptibility to contamination, errors due to temperature effects and the like, so that the performance of such devices is poor.

Instruments are available providing a superior performance. Such instruments generally utilise electrical or electronic techniques and typically, in such an instrument, the resistance, capacitance, or other electrical characteristic of a humidity sensitive film or layer is measured and a corresponding electrical signal derived thereby is converted to an appropriate measurement of humidity. In such instruments, the electrical signal obtained from the humidity sensing film or layer is once again susceptible to drift, hysteresis, polarisation, temperature effects and the like and such instruments incorporate more or less elaborate means for correcting for such effects electronically, and as a consequence such instruments are expensive to manufacture and are sometimes unwieldly in use.

It is an object of the present invention to provide an improved instrument for use in humidity measurement and control which avoids at least some of the disadvantages set out above.

According to the invention there is provided an instrument for use in humidity measurement and control comprising two identical electrical sensors arranged to provide electrical signals significant of the humidity sensed thereby, said sensors being disposed in physical proximity to one another, but with one of said sensors being kept in an environment at a predetermined set humidity and the other being exposed to the environment of which the humidity is to be measured, means for ascertaining, from the electrical signals provided by said sensors, the difference between the humidities represented by these signals, whereby the measured humidity can be determined as corresponding to the predetermined set humidity offset by said difference.

Embodiments of the invention are described below by way of example with reference to the accompanying drawings in which:–

Figure 1 is a sectional view showing the two sensors of an apparatus embodying the invention,

Figure 2 is a schematic circuit diagram illustrating a control system utilising a measuring instrument embodying the invention, and

Figure 3 is a schematic circuit diagram showing a combined measurement and control system utilising a measuring instrument embodying the invention.

Referring to Fig. 1, a preferred apparatus embodying the invention incorporates two sensors 10, each comprising a pair of electrodes 12 applied to an impermeable substrate 14, the two electrodes of each sensor 10 being covered by a respective deposited layer 16 of a humidity-sensitive material which undergoes a reversible change in electrical characteristics upon a change in humidity. One of the sensors, referenced 10A is exposed on the substrate 14 whilst the other, referenced 10B, is covered by a housing A sealingly secured at its edges to the substrate 14 around the sensor 10A and enclosing the sensor 10A in a closed chamber hermetically sealed with respect to the exterior so that moisture cannot be lost from or gained by the chamber as a whole. The chamber defined within the housing A is divided into two parts or sub-chambers by a membrane C, the reference element 10B being disposed in the lower one of these sub-chambers (as viewed in Fig. 1) and the other upper sub-chamber containing a body B of known equilibrium humidity. The membrane C allows the passage of water vapour between the two sub-chambers but prevents the passage of material in the solid or liquid phase between the two sub-chambers. As will become clear from what follows, the sensor 10A acts as a measuring element whilst the sensor 10B acts as a reference element.

The body B may be a piece of a absorbent material impregnated with a known salt or a known combination of salts and with sufficient water to ensure that the body B is soaked with a saturated solution of the salt or combination of salts. The humidities generated by saturated solutions of various salts or of various combinations of salts are well documented so that it is possible by this means, to provide a predetermined, known humidity within the chamber bounded by housing A and the substrate 14. However, any solid capable of absorbing water and having a known equilibrium humidity may be utilised as the body B. Clearly the humidity in the sealed chamber and to which the sensor 10B is subjected may be ascertained after the body B has been encapsulated in the chamber, by calibration of the instrument as a whole with reference to some atmosphere of known humidity.

In the discussion of the preferred embodiments below, it is assumed that the measured electrical property of each sensor 10a, 10b, is the electrical resistance between the electrodes 12 of the sensor and whilst this is the arrangement most readily realised, it will be

appreciated that other electrical properties, such as capacitance, may be utilised in other sensors in devices embodying the invention.

In the embodiments described below with reference to Figs. 2 and 3, and in various other embodiments, (not shown) which may be devised utilising the part of the apparatus illustrated in Fig. 1, the part of the apparatus shown in Fig. 1 is placed in the environment of which the humidity is to be sensed, and the two sensors 10A and 10B are connected in respective arms of an electrical bridge circuit from which is derived an electrical signal, indicative of the imbalance of the bridge, and which is used as a measure of the sensed humidity of the environment.

The advantages of the system outlined are as follows:–

The two sensors 10A, 10B, are disposed in proximity to one another on the same substrate 14 and thus are maintained at substantially the same temperature. Furthermore, the two devices, being of closely similar construction, have the same temperature coefficient. As a result, and because of the electrical bridge arrangement utilised, changes in the resistances of the two sensors due to changes in temperature are equal and as regards their effect on bridge balance, cancel each other out. Likewise, ageing and polarisation take place at the same rate on both elements and the effects of these factors on bridge balance likewise cancel. The effect of the bridge arrangment is in general to cancel out all such effects which act in common upon the two sensors 10A, 10B.

Assuming the resistance bridge to be balanced when both sensors 10A, 10B are at the same humidity, the voltage sensed across the bridge is substantially proportional to the difference in humidity between the two sensors 10A, 10B, the polarity of the difference signal depending upon which element 10A, 10B has the higher humidity, so that if the humidity of the measuring element is higher than that of the reference element a voltage proportional to the difference in humidity is generated in one direction while if the humidity of the measuring element is lower than that of the reference element a voltage proportional to the difference in humidity is generated in the opposite direction. This voltage can be used in several ways.

Thus, for example, the voltage referred to can be used as a measure of humidity, for instance if the reference element is placed in a humidity of 50% r.h., the measuring element may measure from 0 to 50% r.h. in the negative direction and from 50 to 100% r.h. in the positive direction. An indicator can be electronically arranged to show numbers from 0–100. Alternatively the voltage referred to can be utilised in a control system in which, for example, the reference element can be kept at the humidity at which the atmosphere is to be controlled. The measuring element will be at the ambient humidity. High humidities will be indicated by a bridge voltage output in one direction and low humidities by a voltage output in the opposite direction. The voltage signal obtained can be used in conjunction with a relay or similar device to activate humidifiers, dehumidifiers, heaters, fans, or alarms. An arrangement of this kind is shown in Fig. 2, discussed in more detail below. In such an arrangement, different humidity "set points" can be obtained by using different reference humidities at which the reference element 10B is kept.

In another arrangement the reference element can be kept at a known humidity. The range of humidities to be controlled can be electronically calibrated and the "set point" can be electronically adjusted to give control at the humidity required. An arrangement of this kind is shown in Fig. 3 discussed in more detail below.

Referring to Fig. 2, the sensors 10A, 10B, are connected in respective arms of a resistance bridge, including also resistances 20 and 22 connected in the other arms of the bridge. The voltage of a voltage source 24 is applied to the bridge and the voltage signal appearing across the bridge is applied to a comparator 26, the output of which is applied to an on/off control device indicated schematically as a relay 28, controlling the energisation of, for example, a heater, fan, alarm or the like. In order to minimise polarisation effects, the voltage source 24 is preferably an AC source. In such an arrangement it will, of course, be necessary for the comparator 26 to be phase sensitive, having regard to the AC source 24 as a reference, but this will present no difficulty to those skilled in the art.

In the arrangement shown in Fig. 3, the voltage output of the bridge is sensed by an amplifier 30 providing an output signal on its output 32, which is proportional to the voltage across the bridge (and thus, as discussed above, proportional to the humidity sensed by element 10A). Where the voltage source 24 is an A.C. source the amplifier 30 may be arranged to provide a D.C. output signal the sign of which, indicative of whether the humidity sensed by the sensing element 10B is greater or less than the reference humidity of element 10A, is dependent on the phase of the sensed voltage difference across the bridge relative to source 24, but this will present no difficulty to those skilled in the art. The output voltage appearing on output 32 is also applied to one input of a comparator 34, the other input of which is connected to a variable set-point or reference voltage source, the comparator 34, like the comparator 26 in Fig. 2, being arranged to operate an on/off control device represented as a relay 28. Thus, to achieve control of devices such as fans, heaters or the like, at a particular humi-

dity, it is merely necessary to set the set-point voltage for comparator 34 at the appropriate setting, rather than change the humidity at which reference element 10B is kept. In the arrangement shown in Fig. 3, the two elements 10A, 10B are connected in series between the terminals of the voltage source 24 (whereas in the arrangement of Fig. 2 each sensor is connected, in series with its respective resistor 20 or 22, between terminals of the voltage source 24).

Correct functioning of the apparatus described can be checked by placing temporarily over the 10A a housing, identical with the housing A and containing a reference body B adapted to provide the same reference humidity as that to which the element 10B is exposed. If the apparatus is functioning correctly, once equilibrium has been reached, the bridge including element 10A and 10B should achieve a null balance.

CLAIMS

1. An instrument for use in humidity measurement and control, comprising two identical electrical sensors arranged to provide electrical signals significant of the humidity sensed thereby, said sensors being disposed in physical proximity to one another, but with one of said sensors being kept in an environment at a predetermined set humidity and the other being exposed to the environment of which the humidity is to be measured, means for ascertaining, from the electrical signals provided by said sensors, the difference between the humidities represented by these signals, whereby the measured humidity can be determined as corresponding to the predetermined set humidity offset by said difference.

2. An instrument according to claim 1 including means for producing an electrical signal corresponding in magnitude to the algebraic sum of the magnitudes of the electrical signals from said two sensors.

3. An instrument according to claim 1 wherein said sensors are connected in an electrical bridge circuit and the voltage across said bridge circuit is measured as a measure of said difference.

4. An instrument according to any preceding claim, wherein said sensor kept at a predetermined set humidity is disposed in a chamber in which is also disposed a saturated solution of a salt or salts, separated from the sensor by a vapour phase separating membrane.

5. An instrument for use in humidity measurement or control substantially as hereinbefore described with reference to, and as shown in, Fig. 1 of the accompanying drawings.

6. A humidity sensitive control system, substantially as hereinbefore described with reference to, and as shown in, Fig. 2 of the accompanying drawings.

7. A humidity measuring instrument substantially as hereinbefore described with reference to, and as shown in Fig. 3 of the accompanying drawings.

8. Any novel feature or combination of features described herein.

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